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PROGRAM STATUS 4th QUARTER – FY 1989

FUSION TECHNOLOGY DEVELOPMENT

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PROGRAM STATUS REPORT
CONTRACT DE-AC03-89ER52153
4TH QUARTER - FY89

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FUSION TECHNOLOGY DEVELOPMENT 4th QUARTER FY89

- **Reactor Studies — ARIES**

- The ARIES-I high field tokamak design is nearing completion, yielding a self-consistent “near-term physics” reactor with reasonable cost and very attractive safety features.
- A helium-cooled solid breeder blanket with SiC-composite structure contributes significantly to the attractive safety characteristics.

- **RF Technology**

- Model ICRF tetrode tube anodes demonstrated the equivalent of 3.3 MW of power dissipation, well above the 2.5 MW goal. Full-sized tubes are being constructed for testing at JAERI in April 1990.

- **Fusion Nuclear Technology**

- International fusion nuclear data cooperation activities continued to expand.
- The U.S./Japan/PRC joint beryllium experiments in China have been delayed by the current political climate.

- **Plasma Facing Components**

- The DIII-D divertor conditions have been characterized for analysis to compare to erosion measurements.
- The conceptual design of a mechanism to insert material samples into the DIII-D divertor is nearing completion.

- **Fusion Materials**

- As a final activity of this program, data on “low activation” manganese-stabilized austenitic steels were prepared for presentation to ITER.

PROGRAM STATUS
4TH QUARTER - FY 1989

TASK: REACTOR STUDIES

B/R NO: AT-15-03

FY89 FUNDING: \$300 K

CONTRACT NO: DE-AC03-89ER52153

FY89 PLAN: \$300 K

GA PRINCIPAL INVESTIGATOR: C. P. C. WONG

SAN PROJECT MANAGER: C. BEIGHLEY

OFE PROGRAM MANAGER: S. BERK

PLANNED ACTIVITIES/GOALS	ORIGINAL TARGET	CURRENT TARGET	COMPLETION DATE
1. Complete scoping of the ARIES-I High Field Tokamak Reactor Concept	1 st Q FY89		1 st Q FY89
2. Develop the scoping design of the ARIES-III Advanced Fuel Tokamak Reactor	2 nd Q FY89	1 st Q FY91	
3. Develop the scoping design of the ARIES-II Advanced Physics Tokamak Reactor	3 rd Q FY89	2 nd Q FY90	
4. Complete conceptual design and evaluation of the ARIES-I High Field Tokamak Reactor	4 th Q FY89	1 st Q FY90	

REMARKS:

The ARIES project has redesignated and rescheduled the ARIES-III Advanced Physics Tokamak Reactor design to become the ARIES-II second stability design to be investigated after the completion of the ARIES-I design.

PROGRAM STATUS

4TH QUARTER - FY 1989

REACTOR STUDIES

HIGHLIGHTS:

- The ARIES-I design is nearing completion. The ARIES-II design work will begin soon and will be based on an advanced physics DT tokamak operating in the second stability regime. Work on D³He advanced fuels will be deferred to ARIES-III.
 - The ARIES-I blanket design team has selected the 5 MPa helium-cooled design as the reference blanket for the study. Beryllium neutron multiplier will be used together with an advanced super-critical steam cycle for power conversion. When compared to the no-beryllium and the conventional Rankine cycle design, this reference design will improve the thermal performance of the reactor by about 50%.
-

During the months of July, August, and September of 1989, the ARIES tokamak reactor continued the detailed design of the ARIES-I "near-term physics" reactor design. We focused our effort on the helium-cooled solid breeder, SiC-composite structure blanket design and neutronics analysis. Scoping analysis on the advanced fuel reactor designs is continuing at a low level.

With the ARIES-I design nearing completion, we are making plans for the ARIES-II design study. There is a need to have a "mainline" advanced physics tokamak design ready for use in the comparison of magnetic and inertial fusion that is planned to be done in the summer of 1990. Because of this need, the ARIES team has decided to set aside work on D³He advanced fuel designs for the time being and to focus our attention on a D-T advanced physics tokamak design operating in the second regime of MHD stability for the ARIES-II design. We will return to our D³He advanced fuel studies for ARIES-III in FY91.

1. Blanket Design

Clement Wong and Edward Cheng attended the ARIES-I blanket design selection meeting at UCLA. The team completed the mission of evaluating the 0.5 MPa CO₂ particulate-cooled blanket and the 5 MPa helium-cooled blanket. The latter one was selected as the reference blanket. This selection was mainly based on two points. The

first is the lack of experimental data for the erosion of Li_4SiO_4 particles on the SiC wall. Even though we can project that due to the effect of an energy threshold for erosion the wall erosion will be negligible, we cannot quantify the erosion at this time without relevant experimental data. The second point for the selection was that, by careful design of the SiC-composite first wall, we have confidence that we can design it to withstand the maximum surface loading of 0.85 MW/m^2 and to operate at a coolant pressure of 5 MPa. Since the coolant technology of high pressure helium is well developed, it became reasonable for us to select it as the blanket coolant for the ARIES-I reactor design.

The blanket team also recommended the use of beryllium metal as the neutron multiplier and the advanced super-critical steam cycle (SCSC) for power conversion design. The use of beryllium metal can improve the blanket energy multiplication (M) from 1.05 to 1.36. The SCSC at a blanket coolant outlet temperature of 650°C is projected to have a thermal efficiency η of 48%. With this combination of design choices, this reference blanket can have a thermal performance ($M\eta$) about 50% higher than the previous design.

With this selection, we have been performing the tasks of coordinating the blanket design, neutronics design and blanket thermal-hydraulic and structural designs.

For the reference 5 MPa helium-cooled ARIES-I blanket design we proposed to use sphere-pac beryllium multiplier and Li_4SiO_4 solid breeder materials. We have put together a relatively simple and credible SiC-composite module design. The blanket module will be formed first of SiC fibers, with inclusion of flow channels and structural supports, before being subjected to high temperature SiC infiltration and brazing. The sphere-pac beryllium multiplier and breeder materials can then be filled into their respective radial zones of the blanket module. Preliminary thermal-hydraulic calculations indicate that the maximum temperature of the first wall can be maintained to less than 1000°C and the Li_4SiO_4 breeder can be designed to stay within the temperature window of 320°C to 950°C .

Due to the high lithium burnup, the low melting point lithium meta-silicate may form, which can lead to a two phase mixture of meta- and ortho-silicates when the blanket is operating at high temperature. The tritium release behavior of this mixture is uncertain. Barry McQuillan of GA proposed the design approach of mixing a small amount of Li_2O into Li_4SiO_4 . This can potentially alleviate the chemical stability problem of Li_2O and the low melting point problem of lithium meta-silicate. Dai-Kai

Size of ANL is evaluating this material option. As a backup, the solid breeders lithium aluminate and lithium oxide can be used.

Wong attended a special ARIES-I design integration meeting at UCLA, September 11-14. He proposed a helium-cooled divertor design, routing the coolant toward the peak heat flux area first, where the heat transfer is further enhanced by 2-D or 3-D roughening. The pressure drop of this design appears acceptable. The divertor coolant exiting at 400°C can also be used for power conversion.

2. Neutronics

Ed Cheng continued to evaluate the neutronics design of the ARIES-I blanket. He considered the burnup of beryllium and ^6Li , activation of the Al-alloy vacuum chamber and accidental biological hazards of different blanket structural materials and coolants. He found that SiC structure poses the minimum hazard and $^{17}\text{Li}^{83}\text{Pb}$ poses the highest, as measured by the latent dose index (LDI). Since the SiC structure will not melt under even the worst loss of coolant accident, there will be no material release to the public and therefore no contribution to LDI.

At a lithium enrichment of 20% with our present design, the 1-D calculation shows that we can have a tritium breeding ratio of 1.12 and a blanket energy multiplication of 1.36. Based on up-to-date results on the $^{27}\text{Al}(n,2n)$ cross-section, Cheng found that the induced radioactivity from LiAlO_2 can be an order of magnitude lower than calculated before. This result indicates that by averaging, LiAlO_2 can also be considered as a low activation material for waste disposal. The potential advantage of Li_4SiO_4 over LiAlO_2 is on the generation of afterheat. When LiAlO_2 is used, special care on the blanket design will be needed to make sure that the afterheat power generated will not cause unacceptable release of radioactivity from the blanket.

3. Advanced Fuels

Mike Schaffer continued to evaluate the application of rectennas as a power conversion option for the ARIES-III, advanced fuel design. He analyzed the performance of a large array of closely coupled short dipole antennas, such as might be used in a rectenna system to convert synchrotron power from the plasma. The frequency dependence of the array is no better than that of an individual dipole. Therefore, this kind of system is not very attractive for the conversion of the very broadband synchrotron radiation for the ARIES-III reactor design.

Two papers, one by Wong on the ARIES-I blanket design and another by Cheng on the ARIES-I neutronics design were prepared and were presented at the IEEE 13th Symposium on Fusion Engineering, October 2-5, in Knoxville, TN.

PROGRAM STATUS
4TH QUARTER - FY 1989

TASK: RF TECHNOLOGY

B/R NO: AT-15-01-024

FY89 FUNDING: \$340 K

CONTRACT NO: DE-AC03-89ER52153

FY89 PLAN: \$340 K

GA PRINCIPAL INVESTIGATOR: D. B. REMSEN, JR.

SAN PROJECT MANAGER: C. BEIGHLEY

OFE PROGRAM MANAGER: S. STATEN

PLANNED ACTIVITIES/GOALS	ORIGINAL TARGET	CURRENT TARGET	COMPLETION DATE
1. Purchase tube	1 st Q FY88	1 st Q FY89	1 st Q FY89
2. Tube tests at JAERI	3 rd Q FY88	2 nd Q FY89	2 nd Q FY89
3. Analyze tube test results	3 rd Q FY89		3 rd Q FY89
4. Upgrade X2242 tube	4 th Q FY89	1 st Q FY90	

REMARKS:

The tube improvements developed as part of the test program and the anode upgrade will be combined. The rebuilt test tube and the anode upgrade tube will be delivered in November 1989 for testing in the spring of 1990 at JAERI.

PROGRAM STATUS

4TH QUARTER - FY 1989

RF TECHNOLOGY

HIGHLIGHTS:

- Model tubes demonstrated the equivalent of 3.3 MW of plate dissipation, exceeding expectations.
 - We are now proceeding with construction of full size tubes.
-

X2242 Anode Upgrade Program

The EIMAC X2242 Anode Cooling Upgrade Program is a continuing engineering effort to develop new heat exchanger surface configuration for increasing the surface heat transfer capability and therefore, the net thermal dissipation performance of the tube for any given coolant flow rate and inlet temperature conditions.

1. Full sized tubes having upgraded anode cooler configurations and modified grid patterns are now identified as EIMAC X2274.
2. The EIMAC X2242 anode is a thick walled structure (0.318 in.) whereas the X2274 and the two model tubes have thinner walls (0.235 in.).
3. There are two model tube configurations; "A" and "B".

One model "A" tube and one model "B" tube were tested to internal power density levels exceeding 2.45 kW/cm^2 . This is the internal anode power level for a full sized X2274 tube when dissipating 2.5 megawatts. In addition, both model tubes were then operated at internal power densities exceeding 3.26 kW/cm^2 , or the equivalent of 3.33 megawatts in the X2274. The above noted extraordinary power dissipations were accomplished with nearly half of the equivalent coolant volumetric flow now recommended by EIMAC for the X2242.

The results for this phase of the program are summarized in Table I. The water cooling requirements for the planned X2242 upgrade program (now the X2274) are shown in Table II.

The best model tube "B" accomplishment of 14.17 kW/GPM (at 425 kW) scaled up to the full sized X2274 results in the estimated cooling requirements shown in Table III.

Table I
MODEL TUBE TEST SUMMARY

Configuration	Testflow (GPM)	Coolant Velocity (ft/sec)	Power Dissipation		Power/ Flow (kW/GPM)	Heat Exchange Surface
			Inner Core (kW/cm ²)	Total (kW)		
Model "A"	55	29.73	3.26	475	8.55	Similar to X2242.
Model "A"	45	24.33	2.51	365	8.11	
Model "A"	30	16.22	2.91	424	14.13	
Model "B"	55	21.59	3.37	490	8.90	Same as X2274.
Model "B"	45	17.65	2.58	375	8.33	
Model "B"	30	11.77	2.92	425	14.17	

The following are reference data for full size tube operational requirements.

X2274	350 (est.)	49.88	2.451	2500	7.14
X2274	175 (est.)	24.94	1.373	1400	8.00
X2242	350	53.52	1.569	1600	4.57

Table II
X2274 POWER DISSIPATION REQUIREMENTS

Power Dissipation (kw)	Coolant Flow (Water, GPM)	Inner Anode Power Dissipation (kW/cm ² Active)	Coolant Temp. Rise (°C Bulk)
2500	350	2.451	27.0
1400	175	1.373	30.3

The above data shows that, for the X2274, the required internal anode power density of 2.451 kW/cm² at 2500 kW dissipation may be expected to be cooled with less than the presently specified 350 GPM. In fact, 2500 kW may be dissipated with flows estimated to be as low as 176 GPM for a 50°C temperature rise.

Table III
Estimated X2274 Cooling Requirements Based on Best Model Tube Data

Power Dissipation (kW)	Coolant Flow (GPM)	Coolant Velocity (ft/sec)	Coolant Temp. Rise (°C)
3000	212	30.2	53.5
2500	176	25.1	53.7

As seen from the above data, the model tubes have indeed demonstrated capabilities that when scaled to the full size tube give confidence that we will be able to demonstrate the program requirements for 2.5 MW.

The plan for 1st quarter 1990 is to complete the demonstration of the full size tubes incorporating the changes tested and verified in the model tube tests.

ICRH Tube Tests

The last week of October a U.S./Japan steering committee meeting is scheduled to be held in Japan at the Naka site. Stan Staten from OFE, M. Loring from Varian EIMAC and Doug Remsen of GA will represent the U.S. Discussions concerning schedule and technical considerations will be held. At the moment it is expected that tube tests of the upgraded, improved X2274 tubes will be conducted in the RF test facility at JAERI in April/May of 1990. Tubes will probably be shipped in March of 1990.

Final details are expected to be resolved during the steering committee meeting in October.

Contract Management Summary Report

TITLE:	RF TECHNOLOGY	B/R NO: AT1501024	CONTRACT NO.:	DE-AC03-89ER52153
CONTRACTOR:	GENERAL ATOMICS P.O. BOX 85608 SAN DIEGO, CA. 92138	COST & LABOR PLAN DATE: MAY 25, 1989	START DATE:	SEPTEMBER 30, 1988
			COMPLETION DATE:	SEPTEMBER 30, 1989

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
PLANNED	\$10	\$11	\$59	\$60	\$36	\$24	\$21	\$18	\$34	\$23	\$19	\$25	\$340
ACTUAL	\$15	\$5	\$66	\$45	\$12	\$12	\$2	\$3	\$4	\$2	(\$4)	\$65	\$227
VARIANCE	(\$5)	\$6	(\$7)	\$15	\$24	\$12	\$19	\$15	\$30	\$21	\$23	(\$40)	
CUM VAR	(\$5)	\$1	(\$6)	\$9	\$33	\$45	\$64	\$79	\$109	\$130	\$153	\$113

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
PLANNED	0.2	0.4	0.4	2.0	1.0	0.2	0.2	0.2	0.3	0.3	0.3	0.3	5.8
ACTUAL	0.3	0.4	0.2	1.0	0.9	0.1	0.1	0.2	0.1	0.2	0.0	0.1	3.6
VARIANCE	-0.1	0.0	0.2	1.0	0.1	0.1	0.1	0.0	0.2	0.1	0.3	0.2	
CUM VAR	-0.1	-0.1	0.1	1.1	1.2	1.3	1.4	1.4	1.6	1.7	2.0	2.2	

SIGNATURE OF PARTICIPANT'S PROJECT MANAGER & DATE: _____

PROGRAM STATUS
4TH QUARTER - FY 1989

TASK: FUSION NUCLEAR TECHNOLOGY

B/R NO: AT-15-02-01A

FY89 FUNDING: \$80 K

CONTRACT NO: DE-AC03-89ER52153

FY89 PLAN: \$80 K

GA PRINCIPAL INVESTIGATOR: E. T. CHENG

SAN PROJECT MANAGER: C. BEIGHLEY

OFE PROGRAM MANAGER: S. BERK

PLANNED ACTIVITIES/GOALS	ORIGINAL TARGET	CURRENT TARGET	COMPLETION DATE
1. Represent OFE at CSEWG, U.S. NDC, and IAEA meetings	←	ONGOING	→
2. Update OFE nuclear data needs assessment and nuclear data request list	4 th Q FY89		4 th Q FY89
3. Perform comparative analysis of benchmark fusion blankets using U.S. and IFENDL libraries	4 th Q FY89		4 th Q FY89
4. Coordinate the joint US/PRC and U.S./Japan integral experiment on beryllium - Complete pre-experiment analysis	4 th Q FY89		4 th Q FY89
5. Recommend improvements in nuclear data libraries and recommend libraries for use in fusion reactor development	4 th Q FY89		4 th Q FY89

REMARKS:

PROGRAM STATUS

4TH QUARTER - FY 1989

FUSION NUCLEAR TECHNOLOGY

HIGHLIGHTS:

- Cheng attended and conducted fusion nuclear data coordination activities in the following meetings:
 1. IAEA Consultants' Meeting on Measurements of Activation Cross Sections Leading to Production of Long-Lived Radionuclides, September 11-12, at Argonne National Laboratory, Chicago.
 2. Nuclear Energy Agency Nuclear Data Committee Specialists' Meeting on Activation Cross Sections for Fission and Fusion Energy, September 13-15, also at Argonne National Laboratory, Chicago.
 3. Sixth Review Meeting on DOE Nuclear Physics Program to Measure High Priority Nuclear Data for Fusion Energy, September 19-21, Athens, Ohio.
 - A U.S./PRC/Japan Workshop on Beryllium Nuclear Data, previously scheduled for October 1989 in Beijing, PRC, has been postponed due to the current political climate between PRC, U.S., and Japan.
-

During the quarter of FY89 we prepared two benchmark problems for IAEA activities. We are providing leadership roles in both activities. One of them is for the ANISN neutron transport code verification project. The participants are expected to submit the results by December 1989 to the IAEA Nuclear Data Section in Vienna. The other benchmark problem is for the activation calculation comparison study, also under the IAEA/NDS. This study project is a long-term one and we expect to expand in the future to include other IAEA and/or IEA activities relevant to fusion reactor development.

Cheng attended the IAEA Consultants' Meeting on Measurements of Activation Cross Sections Leading to Production of Long-Lived Radionuclides, September 11-12, at Argonne National Laboratory, Chicago. The IAEA sponsored measurement activities were in response to a recommendation made by the U.S. DOE/OFE nuclear data requirements program in November 1987. As a result of this meeting, the following long-lived

activation cross sections were reported to have measurements performed: $^{27}\text{Al}(n, 2n)^{26}\text{Al}$, $^{63}\text{Cu}(n, p)^{63}\text{Ni}$, ^{94}Nb , $^{109}\text{Ag}(n, 2n)^{108m}\text{Ag}$, $^{179}\text{Hf}(n, 2n)^{178m}\text{Hf}$, $^{151}\text{Eu}(n, 2n)^{150}\text{Eu}$, $^{153}\text{Eu}(n, 2n)^{152}\text{Eu}$, and $^{182}\text{W}(n, n'\alpha)^{178m}\text{Hf}$.

Cheng was invited to give talks on the nuclear data needs for fusion energy at the Nuclear Energy Agency Nuclear Data Committee Specialists' Meeting on Activation Cross Sections for Fusion and Fission Energy, September 13-15, Argonne National Laboratory.

A set of activation cross section data needed for low activation fusion reactor development was compiled based on the following considerations: decay heat, shutdown dose rate, latent dose hazard potential, and waste disposal. The results of this investigation were presented at the IAEA Nuclear Data Section and Nuclear Energy Agency Nuclear Data Committee meetings.

Cheng participated in the Sixth Review Meeting on DOE Nuclear Physics Program to Measure High Priority Nuclear Data for Fusion Energy, September 19-21, Athens, Ohio. A report on individual laboratory progress on work performed for the Department of Energy Office of Nuclear Physics (formally Office of Basic Energy Sciences) Program to Meet High-Priority Nuclear Data Needs of the Office of Fusion Energy was compiled and distributed. Ed Cheng of the OFE Nuclear Data Requirements program serves as Scientific Secretary and Professor Steve Grimes of Ohio University is Chairman of the review meeting. More than 35 scientists participated, including nine foreign observers from UK, FRG, Japan, Holland, Belgium, and China.

Dr. Syed Qaim of KFA, Jülich, West Germany, visited GA on September 22 to discuss the coordination of nuclear data development activities. Qaim is presently Chairman of the OECD NEA Nuclear Data Committee.

A Beryllium Nuclear Data Workshop previously scheduled to be held in Beijing, PRC, in October this year has been postponed due to the current political climate between PRC, U.S., and Japan. The PRC scientists also favor the delay of the workshop because the beryllium experiment in Chengdu has not proceeded as smoothly as expected.

PROGRAM STATUS
4TH QUARTER - FY 1989

TASK: PLASMA-FACING COMPONENTS

B/R NO: AT-15-02-031

FY89 FUNDING: \$100 K

CONTRACT NO: DE-AC03-89ER52153

FY89 PLAN: \$ 95 K

GA PRINCIPAL INVESTIGATORS: C. P. C. WONG/K. R. SCHULTZ

SAN PROJECT MANAGER: C. BEIGHLEY

OFE PROGRAM MANAGER: M. COHEN

PLANNED ACTIVITIES/GOALS	ORIGINAL TARGET	CURRENT TARGET	COMPLETION DATE
1. Fabricate and install in DIII-D a set of 12 graphite divertor tiles for erosion/redeposition studies.	3 rd Q FY89		3 RD Q FY89
2. Remove divertor test tiles from DIII-D and compare measured erosion/redeposition with predictions of analytic models.	4 th Q FY89	1 st Q FY90	
3. Design for installation on DIII-D sample transfer and optics support equipment for time-resolved erosion/redeposition measurements.	4 th Q FY89	1 st Q FY90	

REMARKS:

It is now planned to vent DIII-D in mid-December 1989. The 12 divertor tiles will be removed at that time more detailed analysis of ellipsometry sensitivity by SNL-L indicates the need for different ports than originally selected.

PROGRAM STATUS

4TH QUARTER - FY 1989

PLASMA-FACING COMPONENTS

HIGHLIGHTS:

- Exposure of 12 well-characterized graphite tiles in the divertor region of DIII-D continues. These tiles will be removed during the next vent of DIII-D, now scheduled in mid-December of 1989.
 - The operational history of the DIII-D divertor has been characterized into five modes: ohmic, L-mode, H-mode, disruption, and off-normal. Power-weighted average divertor strike point locations have been characterized for these modes for use in the erosion analysis.
-

Phase 1 - Integral Tests

In the first phase of this task, integral erosion measurements, twelve well-characterized graphite tiles were installed into the lower DIII-D divertor in March 1989. These will be left until the next vent, now scheduled for December 1989. Preliminary estimates predict 100-200 microns of gross erosion and 10-20 microns of net erosion. This should be readily confirmed by SNL-L using a mechanical profilometry technique with ± 1 micron accuracy.

The operational history of the DIII-D divertor has been characterized into five modes: ohmic, L-mode, H-mode, disruption, and off-normal. Power-weighted average divertor strike point locations have been characterized for these modes for use in erosion analysis. An example is shown in Fig. 1. Together with some preliminary $T_e(r)$ and $N_e(r)$ Langmuir probe data provided by D. Buchenauer of Sandia-Livermore, this information was transmitted to J. Brooks of ANL as inputs to the REDEP code for erosion and redeposition calculation.

Phase 2 - *In Situ* Tests

In the second phase, real-time measurements of the erosion during a plasma-discharge, SNL-L is developing a thin film laser ellipsometry technique that should allow ± 1 nm measurement of the thickness of a thin carbon film in the divertor region during a plasma shot. More detailed analysis of the sensitivity of the ellipsometry technique for carbon

Fig. 1. Power-weighted divertor strike point location in DIII-D.

materials by SNL-L shows that the laser beam should impinge on the target at an angle of 70° to 75° from perpendicular for maximum sensitivity. R. Gallix is working with R. Snider to identify available DIII-D ports that will meet the requirements for the ellipsometry in-situ erosion/redeposition measurement experiment. They have identified a tentative set of three DIII-D ports for diagnostic laser beam inlet/outlet and sample insertion into the divertor (150° V-1). GA is also developing the design of the sample change mechanism that will facilitate in-situ ellipsometry measurements between plasma operation, in-situ ellipsometry measurements between plasma shots on sample insertion and retrieval for laboratory measurements.

We had an information meeting with the DIII-D experimental staff to explain the in-situ erosion studies goals and plans. The program objective, schedule, and status were reviewed. Key items that we need to resolve are the following:

1. To define the feasibility of applying the technique of ellipsometry to in-situ measurement of graphite divertor erosion and redeposition layer thickness, and
2. To confirm the selection of three available ports in DIII-D for our experiment.

We had a GA/SNL-L team meeting on September 19 to discuss the status of our action items. The key task is for us to generate an adequate technical understanding of the application of the ellipsometry method for in-situ measurement of divertor tile erosion and redeposition in the DIII-D machine. We have extended our proposed DIII-D Conceptual Design Review Meeting date to allow GA and SNL-L to develop this information.

Applying the laser ellipsometry technique to measurements in DIII-D is a challenging task and verifying that it will be successful before actually trying it is difficult. Our goal is to do on-line in-situ measurements during plasma operation. We have, however, identified several options that are potentially less exacting but that would still allow very valuable information concerning plasma erosion of various divertor materials to be obtained. The options that we are evaluating are:

1. In-situ on-line measurement of net erosion during plasma shots by using the ellipsometry method.
2. In-situ measurement of net erosion between shots by using the ellipsometry method.
3. Ex-situ measurement of net erosion by any established method(s) after the removal of experimental test sample(s).

We are now working with SNL-L to complete evaluation of these options and investigation of the equipment needed to carry out the experiment.

PROGRAM STATUS
4TH QUARTER - FY 1989

TASK: FUSION MATERIALS

B/R NO: AT-15-02-03A

FY89 FUNDING: \$25 K

CONTRACT NO: DE-AC03-89ER52153

FY89 PLAN: \$25 K

GA PRINCIPAL INVESTIGATOR: T. A. LECHTENBERG

SAN PROJECT MANAGER: C. BEIGHLEY

OFE PROGRAM MANAGER: T. REUTHER

PLANNED ACTIVITIES/GOALS	ORIGINAL TARGET	CURRENT TARGET	COMPLETION DATE
1. Coordinate the ITER Structural Materials Data Base with ANL	3 rd Q FY89		3 rd Q FY89
2. Coordinate with the ITER Structural Materials Working Group to review material properties for ITER and to disseminate physical and mechanical properties data sheets for review and comment by the international community	←	ONGOING	→

REMARKS:

PROGRAM STATUS
4TH QUARTER - FY 1989
FUSION MATERIALS

HIGHLIGHTS:

- Close-out activities commenced.
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The data on manganese-stabilized austenitic steels that was obtained and compiled last quarter was prepared for presentation to the ITER team. Manganese steels are favored by the European community and are a backup material for the ITER first wall and blanket structure. The first choice is nickel-stabilized austenitic steel (SS 316).

Continuing uncertainty about FY90 funding required interaction with OFE program management. This activity assisted GA in planning the activities for the remainder of FY89. Close-out appears likely and the data is being packaged for storage.